PCT/GB00/00796.

The Patent Office

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

09/674660

INVESTOR IN PEOPLE

REC'D 01 MAY 2000

WIPO PCT

U

GB00/796

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed Andrew Gersey

Dated 6 April 2000

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Patents Form 1/77

Act 1977

THE PATENT OFFICE
29 APR 1999
RULE 97
RECEIVED BY POST

The Patent Office

30APR99 E443650-6 D01559
P01/7700 0.00 - 9909856.8

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1.	Your reference	MJ/TM/STS.33
2.	Patent application number *(The Patent Office will fill in this part)*	**9909856.8**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	Surface Technology Systems Limited, Imperial Park, Newport, NP1 9UJ.
	Patents ADP number *(if you know it)*	07539679001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	"Chlorotrifluorine Gas Generator System
5.	Name of your agent *(if you have one)*	Wynne-Jones, Laine & James
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	22 Rodney Road, Cheltenham, Gloucestershire, GL50 1JJ.
	Patents ADP number *(if you know it)*	1792001
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(day / month / year)* n/a
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(day / month / year)* n/a
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))*	YES

"Chlorotrifluorine Gas Generator System"

Chlorotrifluorine (ClF_3) is known to be a likely candidate to achieve an improved etch process capability and has recently become increasingly utilised as a "dry chamber-clean" gas to remove very effectively deposits and build-up after other plasma processes. This is more effective and used in preference to gases such as NF_3 which are also highly toxic, but require plasma or other excitation means to allow etching at acceptable rates.

The prior art comprises two alternative methods of ClF_3 supply, either using a conventional cylinder containing the precursor gas or by local electrolytic cell generation. Cylinder ClF_3 gas delivery systems are most commonly used and have been discussed in detail by Verma et al (Semiconductor International, July 1997, p253). Issues such as compatibility of installation materials and thermal gradients require particular attention. These design considerations can have a significant impact on the overall performance of the process.

Supply of ClF_3 has been available in liquid cylinder form and, very recently, developments have focused on the availability of "dry" cartridge delivery systems. This allows the delivery of ClF_3 (in a nitrogen carrier gas), with the advantages that there are neither liquid filled cylinders of extremely hazardous ClF_3 to be transported nor any special storage requirements on-site, as the dry cartridge is solid at ambient temperatures. A limitation of either

the liquid cylinder or dry cartridge ClF_3 delivery syste that they are both subject to fluctuations in the ambient conditions, which could affect the process reproducibility. ClF_3 (which is a liquid at ambient temperature) is delivered from a conventional cylinder as a low vapour-pressure gas. To achieve the high gas flow rates and pressures required for processing, a single cylinder using an external-heating jacket is commonly used. This poses additional facilitisation and safety requirements in order to prevent gas condensation in the delivery lines and components. The situation may be further aggravated depending upon application. For example if the gas is used in applications where it may be switched with another process gas, then the changes in the flow demands of the process may cause the gas to liquefy in the gas lines. This is because of the variable pressure, temperature and flow parameters experienced by the gas delivery system during this process.

Newer delivery systems based on electrolytic cell generation overcome some of these limitations. Such systems are only just becoming commercially available. However a dedicated ClF_3 delivery installation is still needed. Limitations of this dry cartridge ClF_3 delivery system include gas flow fluctuations caused by changes in the ambient conditions which will, in turn, affect the process reproducibility. The cost of the process gas is similar to that for supply of ClF_3 in liquid form but the dry cartridges require exchanging and this will require a service infrastructure and support to be established. In addition, this

method only allows ClF_3 to be generated in the presence of an N_2 carrier gas.

ClF_3 suffers from a combination of increased cost over existing chemistries, greater health and safety risks and limited commercial availability. These factors combine to make the economics and practicalities of implementing this chemistry potentially difficult and/or the installation and transportation thereof extremely hazardous.

According to the invention there is provided a ClF_3 gas generation system wherein supply sources of chlorine and fluorine are connected into a gas reaction chamber enabling generation of ClF_3 gas, and the reaction chamber has a valved outlet for the supply of the ClF_3 gas.

The invention further extends to such a gas generator system wherein the valved outlet from the reaction chamber is connected to a single or multiple process chamber or processing tool in which the ClF_3 gas will be utilised.

This invention provides for the generation of ClF_3 process gas on demand. The ClF_3 is generated locally to the process tool through the direct combination of the precursor gases, fluorine and chlorine, under controlled temperature and pressure reaction conditions. The use of the individual precursor gases offers a considerable improvement over many of the economic, and handling constraints of current methods of supplying ClF_3. In particular, the recent commercial availability of an appropriately scaled local high-purity fluorine generator overcomes many of the safety issues of handling pure high-purity fluorine required for the reac-

tion.

Direct reaction of Cl_2 and F_2 allows the local generation of the ClF_3 although the specific reaction products resulting from the reaction may include other reaction by-products species in the form of Cl_xF_y, but the dominant species can be maintained as ClF_3. Apart from the reaction by-product species, the generated gas can be formed to the same high purity levels as the precursor gases. This high purity is easier to maintain in a smaller scale reaction chamber compared to much larger commercial volume generation systems. For the majority of applications envisaged, the other Cl_xF_y species are not expected to represent any process issues over ClF_3 alone. Other benefits of this invention include lower production cost and ownership costs as well as reduced hazard to personnel.

The reaction chamber can be formed from high purity materials (such as those sold under the Trade Marks Monel (nickel/copper/iron alloy), Inconel (nickel/chromium/iron alloy) and Hastalloy (nickel/molybdenum/chromium/manganese /iron alloy)) which would not be financially feasible with large scale generation systems.

The gas generator for the invention operates with known precursor gases at or near atmospheric pressure, thus virtually eliminating the need for specialised gas delivery systems. Ideally though the gas generation system will be provided with a control system to control the rate of supply of gases from the two supply sources and through the valved outlet from the reaction chamber.

The reaction chamber may be operated at or near atmospheric pressure, going up the range from several Torr to 760 Torr. The reaction chamber temperature can be controlled at between ambient room temperature up to 600°C generally, but probably will lie within the range of 100 - 400°C. Differing temperatures may be maintained in at least 2 separate zones of the reaction chamber.

The most hazardous gas used in the installation will be Cl_2, which is already commonly used in most fabrication plants in the utilisation of semiconductor manufacturing techniques. Other than this, there are no extremely hazardous gases in the installation, until the process demands gas generation (of fluorine gas, followed by ClF_3). This reduces hazardous chemical storage problems and risk of corrosion etc. Long gas lines for the local generation of fluorine on demand from a central store on the installation to the processing environment are eliminated along with the associated risks. Specialised gas delivery systems, containing hazardous chemicals, to the process equipment are also eliminated, which reduces the level of safety precautions needed to protect the operator during use and during any maintenance operations. The generation of the process gas from the ClF_3 gas generator is very competitive as compared with the cost requirement using high-pressure cylinders for the actual gas supply. There would be a significant reduction in the installation cost due to the reduced amount of pipe work for the additional gases and the associated safety requirements such as gas monitoring

systems.

The direct combination of precursor gases can provide ClF_3 for the process chamber by passing the relatively safe precursor gases through a simple heated and pressure-controlled reaction chamber that is local to the tool. The design of the system will be such as to avoid possible adverse reactions during the combination of the precursor gases that may prejudice the overall process. The ClF_3 reaction chamber design allows operation at pressures independent of the process chamber pressure. This can be achieved by allowing the gas product to flow into the process chamber via a pressure control system. The process chamber is then independent of the higher pressure in the reaction chamber and the delivery pressure of the supplied fluorine and chlorine.

The introduction of high purity gases removes the need to "polish" the generated ClF_3 to remove unwanted impurities before passing into the process chamber. The generation of fluorine locally to the tool overcomes the commercial difficulties in obtaining high purity 100% fluorine in a high pressure cylinder and in the quantities required. The choice of supply of chlorine is from high-pressure cylinders, which are commercially readily available and commonly installed within the industry. Other appropriate methods of chlorine simply may be used. Mass flow controllers may be used to precisely meter the flow of Cl_2 and F_2 into the reaction chamber.

The safety requirements for the precursor gases are

already commonplace for the targeted industry. This is not the case for chlorotrifluorine. The production of chlorotrifluorine within a sub-component of a process tool eliminates additional safety precautions that would need to be taken for the supply of such gas from a centralised store. The maintenance of the complete system is eased by the absence of any ClF_3 when the system is not being used for processing.

The quantity of the generated gases can be regulated to that required for the specific application so that the gas consumption is optimised and excess generated gas avoided. The design of a custom-built fluorine-on-demand generator ensures that the ClF_3 is only produced as required from the reaction chamber. The flow rates that can be achieved are not subject to gas delivery restrictions which might be proscribed for ClF_3 delivery from a central store.

The invention may be performed in various ways and a preferred embodiment thereof will now be described, by way of example, with reference to the accompanying drawing, which is a diagrammatic illustration of a typical system of the invention.

The system shown in the drawing is for supplying chlorotrifluorine to a process chamber 1 where a dry process utilising that gas is to take place. The ClF_3 is delivered from a local reaction chamber 2 where precursor gases chlorine and fluorine are combined under conventional heat and pressure controlled conditions. The chlorine source is a cylinder 3 of compressed chlorine. The fluorine source is

a conventional fluorine generator 4. Appropriate valving will include valves provided at A, B, C and D for appropriate isolation and control means. Linked control systems 5 and 6 monitor and maintain the supply to and conditions in the chambers 1 and 2.

From the process chamber gases pass to an exhaust system 7, which in turn leads to an abatement tool 8 (which is usually needed). A bypass outlet 9 leads from the reaction chamber 2 to the exhaust system, whereby gases can be switched into the process chamber 1 only when required for processing. This also allows means for ensuring stable gas composition and flow to be maintained prior to switching into the process chamber.

CLAIMS

1. A ClF_3 gas generation system wherein supply sources of chlorine and fluorine are connected into a gas reaction chamber enabling generation of ClF_3 gas, and the reaction chamber has a valved outlet for the supply of the ClF_3 gas.

2. A system according to claim 1, wherein the chlorine supply source comprises a cylinder of compressed chlorine.

3. A system according to claim 1 or claim 2, wherein the fluorine supply source is a fluorine generator.

4. A system according to any one of claims 1 to 3, wherein a control system is provided to control the rate of supply of gases from the two supply sources and through the valved outlet from the reaction chamber.

5. A system according to any one of claims 1 to 4, wherein the valved outlet from the reaction chamber is connected to a process chamber or processing tool in which the ClF_3 gas will be utilised.

6. A system according to claim 5, wherein an abatement tool is connected from the output of the processing chamber or tool.

7. A system according to claim 6, wherein a bypass connection is provided from the reaction chamber to the abatement tool to enable the process to build up to a stable composition and/or flow prior to supply of the generated ClF_3 to the process chamber or tool.

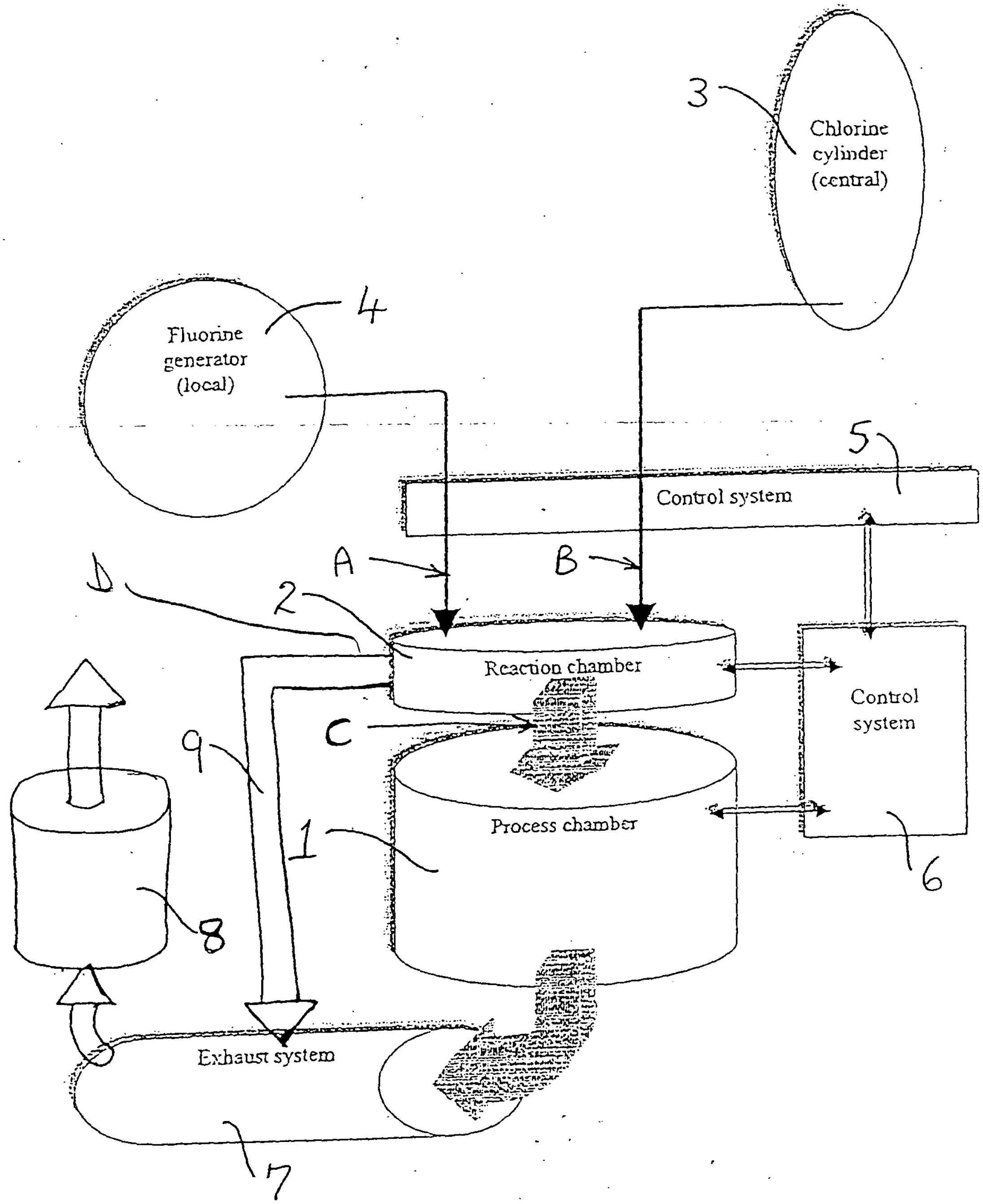
8. A system according to claim 6, wherein a bypass

connection is provided from the reaction chamber to the abatement tool to enable the flow of ClF_3 to be switched into the process chamber as and when required to allow a continuous generation of ClF_3.

9. A method of generating ClF_3 gas using a system as claimed in any one of claims 1 to 8, wherein the precursor gases are fed from the supply sources to the reaction chamber, a combination reaction is performed and the ClF_3 reaction product is fed on to a local processing chamber or tool.

10. A gas generation system or method for generating ClF_3 gas and substantially as herein described with reference to the accompanying drawings.

1/1



3
Chlorine
cylinder
(central)
4
Fluorine
generator
(local)
5
Control system
A
B
D
2
Reaction chamber
Control
system
C
9
1
Process chamber
6
8
Exhaust system
7